

[Designation of Document] Specification

[Title of the Invention] Method for Separating Metal and Inorganic
particles from Metal-Inorganic Particle Composite Material

[Claims]

5 [Claim 1] A method for separating metal and inorganic
particles from a metal-inorganic particle composite material
generated because of dispersion of inorganic particles in base
metal, comprising the steps of:

heating said metal-inorganic particle composite material
10 into a melt;

throwing flux into said melt and bringing said flux into
contact with said melt sufficiently;

subsequently leaving said melt at rest to thereby separate
said melt into an upper layer containing said inorganic particles
15 and a lower layer composed of said metal; and

subsequently recovering said upper layer and said lower layer
individually.

[Claim 2] A method for separating metal and inorganic
particles from a metal-inorganic particle composite material
20 according to Claim 1, wherein loading of said flux is in a range
of from 0.2 parts to 2.0 parts by weight per 100 parts by weight
of said metal-inorganic particle composite material.

[Detailed Description of the Invention]

[0001]

25 [Technical Field to which the Invention Belongs]



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The present invention relates to a method for separating metal and inorganic particles from a metal-inorganic particle composite material generated because of dispersion of inorganic particles in base metal.

5 [0002]

[Prior Art]

Metal-inorganic particle composite materials generated by dispersing inorganic particles in base metal have been used widely for various kinds of members for the purpose of reduction in material weight, improvement in mechanical strength, and provision of functionality. However, waste disposal of such metal-inorganic particle composite materials have come into a problem. In the related art, there have been adopted measures such that the metal-inorganic particle composite materials are simply ground and mixed into other materials as they are, and stored or disposed of by landfills.

[0003]

Further, with growing movement of environmental preservation or recycling of resources, there have been attempts to separate wastes of metal-inorganic particle composite materials into respective components and recover the components. However, in the present circumstances, no effective method is, in fact, established. For example, Japanese Patent Laid-Open No. 41874/1995 discloses the following method. That is, a lump of molten slag containing metal and inorganic particles is dry-ground into fine particles

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having a moderate particle size. The fine slag powder is subjected to low magnetic force selection under magnetic flux density not higher than 1,000 gauss. Thus, iron-component particles in the slag powder is selectively recovered by magnetic attraction. On
5 the other hand, the residual slag powder after the low magnetic force selection is subjected to high magnetic force selection under magnetic flux density ranging from 1,000 gauss to 13,000 gauss. Further, aluminum-component particles or copper-component particles remaining after the high magnetic force selection are
10 recovered individually by separation based on specific gravity.

[0004]

In the method, however, it is necessary to form a lump of slag into fine powder. In addition, it is necessary to prepare a plurality of stages of magnetic force selection different in
15 magnetic flux density, and a step of separation based on specific gravity. Thus, the process includes many steps and is complicated. Besides, the method is applicable only to metal-inorganic composite materials containing magnetic materials. Therefore, the application of the method is limited to some extent.

20 [0005]

Oxides or nonferrous metal mediators generated at the time of manufacturing are generally mixed into metal-inorganic composite materials. However, in any method including the method described above, it is difficult to eliminate such components and
25 separate metal therefrom. Accordingly, the purity of metal

recovered is generally so low that an additional refining work may be required to use the metal as a fresh metal raw material.

[0006]

[Problems that the Invention is to Solve]

5 The invention was developed in consideration of such
circumferences. An object of the invention is to provide a method
for separating metal and inorganic particles from a metal-inorganic
particle composite material, by which high-purity metal can be
recovered efficiently with a simple and easy operation regardless
10 of the composition of the metal-inorganic particle composite
material, particularly regardless of the kind of metal.

[0007]

[Means for Solving the Problem]

15 In order to attain the object, the invention provides a method
for separating metal and inorganic particles from a metal-inorganic
particle composite material generated because of dispersion of
inorganic particles in base metal, the method including the steps
of heating the metal-inorganic particle composite material into
a melt; throwing flux into the melt and bringing the flux into
20 contact with the melt sufficiently; subsequently leaving the melt
at rest to thereby separate the melt into an upper layer containing
the inorganic particles and a lower layer composed of the metal;
and subsequently recovering the upper layer and the lower layer
individually.

25 [0008]

[Mode for Carrying Out the Invention]

An embodiment of the invention will be described below in detail with reference to the drawings.

[0009]

5 Figs. 1A to 1D are schematic views respectively showing steps A to D for explaining a separation method according to the invention. First, as shown in the step A, a metal-inorganic particle composite material 1 to be treated is crushed into suitable lumps, and thrown into a heating vessel 10 having a suitable heating unit 11 such
10 as a high frequency coil.

[0010]

Next, as shown in the step B, the heating vessel 11 is heated to form the metal-inorganic particle composite material 1 into a melt 2. Flux 3 is placed on the liquid level of the melt 2. The
15 flux 3 is, for example, a mixture of NaCl, KCl, Na_3AlF_6 , etc. The components of the metal-inorganic particle composite material 1 are analyzed in advance, and the flux 3 is selected suitably in accordance with oxides or nonferrous metal mediators contained in the metal-inorganic particle composite material 1. In addition,
20 it is preferable that the loading of the flux 3 is set to be in a range of from 0.2 parts to 2.0 parts by weight per 100 parts by weight of the metal-inorganic particle composite material.

[0011]

Next, as shown in the step C, the flux 3 is softly pressed
25 into the melt 2, and mixed by stirring the melt 2 and flux 3 as

a whole. Thus, the flux 3 is brought into contact with metal oxides, hydrogen, nonferrous metal mediators, and the like, contained in the metal-inorganic particle composite material 1 so that coagula of those components are produced in the melt 2. Therefore, in order to increase the purity of recovered metal, it is important to bring the melt 2 and the flux 3 into contact with each other sufficiently to thereby produce coagula as much as possible. The coagula are smaller in specific gravity than metal. Accordingly, by stirring, the coagula float in the melt 2 together with inorganic particles.

[0012]

After being stirred, the melt 2 is left at rest while being heated. Thus, the coagula, the inorganic particles and the flux 3 come to the surface in the form of dross 4. After the dross 4 floats up to the surface sufficiently, heating is stopped, and the melt 2 is kept at rest. As a result, as shown in the step D, the melt 2 as a whole is solidified so that a solid separated into an upper layer composed of the dross 4 containing the inorganic particles 2a and a lower layer composed of metal 2b can be obtained.

[0013]

Then, the solid is extracted from the heating vessel 10, and cut in a border 5 between the upper layer and the lower layer. Thus, the solid can be separated into the metal 2b and the inorganic particles 2a in the dross 4. At this time, respective components of the dross 4 are residual in the vicinity of the cut surface of the lower layer. It is therefore preferable that a predetermined

thickness of the cut surface is eliminated to increase the purity of the metal 2b recovered.

[0014]

Incidentally, the inorganic particles 2b are recovered from
5 the dross 4 in accordance with the kind of the flux 3 used in the
step B. For example, when water-soluble flux 3 is used, the
inorganic particles 2b can be recovered by dissolving the flux 3
in water or a suitable solvent. When high-temperature evaporative
flux 3 is used, the inorganic particles 2b can be recovered by baking
10 the whole of the dross 4.

[0015]

Alternatively, according to the invention, the dross 4 may
be separated from the metal 2b in the following manner. That is,
in the step D, the flux 3 is added, and the melt 2 is stirred and
15 left at rest to make the dross 4 come to the surface. Then, while
being heated, the dross 4 in the upper layer is skimmed with a
net-like member. According to this method, it can be confirmed that
the separation between the dross 4 and the metal 2b is completed
when there is nothing to come to the surface, that is, when the
20 dross 4 disappears. Then, the metal 2b, which is in a melt state,
is poured into a mold as it is, cooled and recovered as an ingot.
On the other hand, the inorganic particles 2a is recovered in the
same manner as above.

[0016]

25 The respective steps described above can be carried out by

very easy operations of heating, stirring, leaving at rest, and cutting (or skimming). In addition, a series of steps can be carried out in the same heating vessel 10, and can be carried out in the atmosphere because the flux 3 is used. Therefore, the method according to the invention is superior also in workability. In addition, metal and inorganic particles can be separated from each other regardless of the composition of the metal-inorganic particle composite material, particularly regardless of the kind of the metal.

10 [0017]

[Advantage of the Invention]

As has been described above, according to the invention, it is possible to separate and recover metal and inorganic particles efficiently with a simple and easy operation regardless of the composition of a metal-inorganic particle composite material, particularly regardless of the kind of the metal. In addition, it is possible to recover the metal with high purity.

[Brief Description of the Drawings]

[Fig. 1]

20 Figs. 1A to 1D are views of steps for explaining a separation method according to the invention.

[Description of the Reference Numerals and Signs]

- 1 metal-inorganic particle composite material
- 2 melt
- 25 2a inorganic particles

2b metal
3 flux
4 dross
5 border
5 10 heating vessel

[Designation of Document] Abstract

[Abstract]

[Problem] To provide a method for separating metal and inorganic particles from a metal-inorganic particle composite material, by
5 which high-purity metal can be recovered efficiently with a simple and easy operation regardless of the composition of the metal-inorganic particle composite material, particularly regardless of the kind of the metal.

[Means for Resolution] A metal-inorganic particle composite
10 material 1 is heated into a melt 2. Flux 3 is thrown into the melt 2, and both the melt 2 and the flux 3 are brought into contact with each other sufficiently. The resulting melt 2 is then left at rest so as to be separated into an upper layer containing inorganic particles 2a and a lower layer composed of metal 2b. Subsequently
15 the upper layer and the lower layer are recovered individually.

[Selected Drawing] Fig. 1